

Semiconductor photonic crystal and microdisk quantum dot devices for chip-based cavity QED

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For semiconductor microcavity-quantum dot systems to realize their potential in cavity QED (cQED)-based implementations of quantum information processing, the cavities must exhibit a sufficiently high quality factor (Q) and small mode volume (V_{eff}) for coherent interaction to take place before dissipation sets in, as well as an efficient input and output channel for transferring light to and from the microcavity-quantum dot interaction region. We have developed optical fiber-pigtailed microcavities in which all of these properties are exhibited. Recent demonstrations include silicon photonic crystal defect cavities with $Q \sim 40,000$ and $V_{\text{eff}} \sim 0.9(\lambda/n)^3$, and AlGaAs microdisk cavities with an embedded layer of quantum dots and $Q \sim 360,000$ and $V_{\text{eff}} \sim 6(\lambda/n)^3$ [1,2]. The latter devices also exhibited lasing with thresholds approaching the transparency values for the quantum dot epitaxy.

We will discuss a number of applications of these systems, including fiber-pigtailed microlasers, high-efficiency single photon sources, and fiber-based optical spectroscopy. In addition, we will compare the relative merits of the different microcavity geometries as they pertain to these applications.

- [1] K. Srinivasan et al., *Physical Review B*, **70**, 081306(R), 2004
- [2] K. Srinivasan et al., submitted, <http://www.arxiv.org/abs/quant-ph/0412085>